

# Permian Rock Units in the Glass Mountains West Texas

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By G. ARTHUR COOPER and RICHARD E. GRANT

CONTRIBUTIONS TO STRATIGRAPHY

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*Nomenclature, revisions in ages, and local correlations of rock units of the Leonard Series and lower part of the Guadalupe Series*



UNITED STATES DEPARTMENT OF THE INTERIOR

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## CONTENTS

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	Page
Abstract.....	E1
Introduction.....	2
Present stratigraphic subdivisions.....	2
Stratigraphic revisions and new units.....	2
Leonard Series.....	2
Hess Formation.....	2
Taylor Ranch Member.....	3
Skinner Ranch Formation.....	4
Dugout Mountain Member.....	4
Cathedral Mountain Formation.....	5
Wedin Member.....	5
Road Canyon Formation.....	6
Guadalupe Series.....	6
Word Formation.....	6
China Tank Member.....	7
Willis Ranch Member.....	7
Apple Ranch Member.....	8
References cited.....	8

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## ILLUSTRATIONS

[In pocket]

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- PLATE 1. Outline map of Glass Mountains, Brewster County, Tex., showing locations of sections.
2. Restored section along south-facing front of Glass Mountains, showing Permian stratigraphic units.



## CONTRIBUTIONS TO STRATIGRAPHY

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#### ABSTRACT

Rock units in the Leonard Series and the lower part of the Guadalupe Series are subdivided and named in order to provide a detailed framework for forthcoming studies of paleontology, biostratigraphy, and correlation. Limestone members in the Hess, Skinner Ranch, and Cathedral Mountain Formations of the Leonard Series and in the Word Formation of the Guadalupe Series are named and correlated locally. The Road Canyon is elevated to the rank of formation and transferred from the Guadalupe Series to the Leonard Series.

#### INTRODUCTION

The Permian rocks of the Glass Mountains have been progressively subdivided since the earliest stratigraphic work in the area by Udden (1917), in accordance with increasing need for detail and for convenience of discussion. Udden (1917) established the basic stratigraphic framework and introduced the names Wolfcamp, Hess, Leonard, and Word for formations that now are classed by the U.S. Geological Survey as largely or entirely Lower Permian (Cohee, 1960). The Wolfcamp and Leonard were elevated to the rank of series (Adams and others, 1939), whereupon Ross (1959, p. 300) subdivided and introduced new formation names for the former Wolfcamp Formation, and Cooper and Grant (1964, p. 1583) introduced new formation and member names for rocks of the former Leonard Formation. Members of the Leonard and Word Formations were established by P. B. King (1931), and their areal extent was mapped by P. B. and R. E. King (see P. B. King, 1931, map). Names for some of their numbered member units were proposed by Cooper and Grant (1964).

We are engaged in a detailed study of the Permian brachiopods of the Glass Mountains (pl. 1) and adjacent regions and find increasing necessity for smaller stratigraphic subdivisions in order to relate the distribution of the brachiopods more closely to the lithic sequence. The present paper introduces some additional names for King's num-

bered members and subdivides the formations yet further by proposing some new member units. The Road Canyon Member of the Word Formation (Cooper and Grant, 1964; "First Limestone" member of P. B. King, 1931) is elevated to the rank of formation and transferred to the Leonard Series.

### PRESENT STRATIGRAPHIC SUBDIVISIONS

The lowest unit in the present subdivision of the Permian in the Glass Mountains is the Neal Ranch Formation of Ross (1959, 1963). This and the overlying Lenox Hills Formation of Ross (1959, 1963) constitute the former Wolfcamp Formation in the Glass Mountains. The succeeding unit is the Skinner Ranch Formation (Cooper and Grant, 1964), divided into the basal Decie Ranch Member (formerly the "western facies of the Hess," of P. B. King, 1931), the middle Poplar Tank Member, and the upper Sullivan Peak Member (formerly the "First Limestone" member of the Leonard Formation, of P. B. King, 1931). The major part of the former Leonard Formation now is designated the Cathedral Mountain Formation (Cooper and Grant, 1964). The basal limestone of the Word Formation ("First Limestone" member of P. B. King, 1931) is presently designated the Road Canyon Member of the Word Formation (Cooper and Grant, 1964). The remaining limestone members of the Word Formation, numbered 2, 3, and 4 by P. B. King (1931), are named below.

### STRATIGRAPHIC REVISIONS AND NEW UNITS

#### LEONARD SERIES

#### HESS FORMATION

The nomenclatural history of the Hess Formation (Udden, 1917) was reviewed by Ross (1963, fig. 2), who followed King (1937) in treating it as a member of the Leonard Formation. Cooper and Grant (1964, p. 1583) suggested returning to P. B. King's (1931) original treatment of this unit as a formation. Ross (1963, fig. 2, p. 30) removed the Wolfcamp age part of the Hess to his newly established Lenox Hills Formation, whose top is marked by the lowest occurrence of the fusulinids *Schwagerina crassitectoria* Dunbar and Skinner and *S. guembeli* Dunbar and Skinner. The lithology of the upper part of Ross' Lenox Hills Formation eastward from a point about 1 mile east of the Hess Ranch house (pl. 1) is typical Hess light-gray-to tan-weathering calcarenite (Ross, 1963, p. 63-65). We include this part of the Lenox Hills Formation of Ross in the Hess Formation and suggest that the top of the Lenox Hills in the eastern part of the Glass Mountains be drawn at the top of the highest bed of conglomerate or calcirudite. In terms of Ross' (1963) sections, the top of the

Lenox Hills by this definition would be just above bed 3 in his section 14, bed 7(?) in section 15, beds 1 and 2 in section 16, bed 17(?) in section 17, bed 13 in section 18, and bed 34 or 35 in section 19. This arrangement is illustrated in our plate 2.

The lower part of the redefined Hess Formation is of Wolfcamp age, equivalent to part of the Lenox Hills Formation of the western part of the Glass Mountains. The upper part has been shown by Ross (1960) to belong to the Leonard Series, and our studies of the brachiopods corroborate his findings. Therefore, the upper part of the Hess is equivalent in age to the Skinner Ranch Formation farther west in the mountains (pl. 2).

**TAYLOR RANCH MEMBER**

The Taylor Ranch Member (new) includes the "fossil bed" (P. B. King, 1931) and the conglomerate that typically occurs just below this level (Ross, 1960, fig. 2). This distinctive unit can be traced for many miles along the mountain front. P. B. King (1931, p. 61) says of the *Perrinites compressus* horizon (bed 19 of section 24, the "fossil bed"), "This is the chief fossil horizon of the Hess and forms a persistent layer traceable for nearly ten miles." The conglomerate immediately below (bed 18 of section 24) "is very persistent and has been traced for several miles to the east and west" of section 24. The conglomerate and "fossil bed" containing diagnostic Skinner Ranch fossils, constitute a distinctive, traceable, and important lithic unit within the Hess; discussion of the unit is facilitated by giving it a formal name as a member of the Hess Formation.

The Taylor Ranch Member is here named for what is now the Bill Neal Ranch; the former name appears on the map by King and King (in P. B. King, 1931). The type section is on the southwest slope of the hill that is capped by the 5750 contour, lying between and slightly south of the hills marked 5767 and 5821, northwest of the Wolf Camp Hills, on the Hess Canyon quadrangle (pl. 1).

The type section contains the following beds:

Taylor Ranch Member :	Feet
Limestone, light-brown, fossiliferous; contains orange-brown chert nodules -----	5
Limestone; contains abundant limestone pebbles and cobbles, interbedded with fossiliferous shale.-----	33
Conglomerate, yellowish; has smooth matrix and limestone pebbles and cobbles as much as 3 inches in diameter-----	2

The Taylor Ranch Member has been mapped (as the "fossil bed") by King and King (in P. B. King, 1931) from a point just east of the conspicuous northwest-striking fault that cuts the east end of the Hess Ranch horst, eastward to a point on the Conoly Brooks Ranch just west of meridian 103, a linear distance of almost exactly 10 miles.

We have sampled the member at many localities throughout this distance, although it becomes increasingly difficult to identify toward the east. Fossils become less abundant in that direction, although the conglomerate persists.

West of the type locality, under the nose of hill 5725 in the Hess Canyon quadrangle (pl. 1), the member contains several rather thick bioherms composed of the large cylindrical sponge *Heliospongia*, other sponges, and numerous brachiopods, gastropods, and pelecypods. Some of the brachiopods, most notably *Spyridiophora*, provide a significant correlation of the Taylor Ranch Member with the upper part of the Skinner Ranch Formation farther west (pl. 2).

#### SKINNER RANCH FORMATION

The undifferentiated part of the Skinner Ranch Formation (Cooper and Grant, 1964) occurs only in the middle of the Glass Mountains front. About a mile east of the Hess Ranch house it merges laterally into the Hess Formation, and west of hill 5021 (pl. 1) it splits into three members (pl. 2): the basal Decie Ranch Member ("western facies of the Hess," of P. B. King, 1931), the Poplar Tank Member, and the uppermost Sullivan Peak Member ("First Limestone" member of the Leonard, of P. B. King, 1931).

#### DUGOUT MOUNTAIN MEMBER

West of the Lenox Hills on Dugout Mountain a considerable thickness of rock occurs above the Sullivan Peak Member and below the lowest beds of the overlying Cathedral Mountain Formation. This interval includes the limestone members of the old Leonard Formation numbered 2-4 by P. B. King (1931). Detailed investigation of the numbered beds in the Lenox Hills and those in Dugout Mountain has shown that the numbers do not all correspond. The rock and fauna of the first limestone in each of the two localities indicates a correlation—it is the Sullivan Peak Member. The higher numbered limestones on Dugout Mountain, however, do not resemble those bearing the corresponding numbers in the Lenox Hills. Instead, the fifth limestone on Dugout Mountain corresponds to the second limestone in the Lenox Hills, and the third and fourth limestones in the Lenox Hills are tongues in the overlying Cathedral Mountain Formation (pl. 2). The interval in Dugout Mountain between the top of the Sullivan Peak Member and the base of the fifth limestone is here named the Dugout Mountain Member. As such, it includes the second, third, and fourth limestones of P. B. King (1931) and the shaly intervals between them. These three limestone beds appear to thin and perhaps to converge northeastward along the back slope of Dugout Mountain. They pinch out somewhere in the covered valley between Dugout Mountain and the Lenox Hills, and the shaly Dugout Mountain Member above the Sullivan Peak Member is only tentatively identified in the Lenox Hills.

The type locality of the Dugout Mountain Member is on the north slope of Dugout Mountain along the line of P. B. King's (1931, p. 133) section 7. There the sequence is mostly yellow shale; it has three limestone tongues and is 514 feet thick. A few small bioherms containing brachiopods occur in the limestone tongues, but ammonoids are common in the brown detrital limestone that makes up the bulk of the tongues. The Dugout Mountain Member thins toward the northeast. The Lenox Hills are only 4 miles away, across a covered valley, but there the only remnant of the member is a bed of limestone above the Sullivan Peak Member, just below the Cathedral Mountain Formation. This limestone is only about 5 feet thick but is lithically like the limestones of the Dugout Mountain Member and contains similar ammonoids. It may represent the edge of one of the Dugout Mountain limestones, or perhaps the coalesced edges of two or more of them.

#### CATHEDRAL MOUNTAIN FORMATION

The Cathedral Mountain Formation (Cooper and Grant, 1964) constitutes the bulk of the former Leonard Formation, excepting only the "First Limestone" member of P. B. King (1931), which now is called the Sullivan Peak Member of the Skinner Ranch Formation, and the beds on Dugout Mountain that make up the Dugout Mountain Member of that formation.

#### WEDIN MEMBER

The base of the Cathedral Mountain Formation is marked in the Lenox Hills and on Dugout Mountain by a limestone member that contains the distinctive productid brachiopod *Institella*, which is important in correlation in the Glass Mountains. This member is the former "Second Limestone" member of the Leonard Formation, of P. B. King (1931) in the Lenox Hills, and the "Fifth Limestone" member on Dugout Mountain. The name herein assigned, Wedin, is derived from the Ava Scribner Wedin No. 1 well on the Decie Ranch (map in P. B. King, 1931), a name doubly appropriate because the ranch formerly was the Wedin Ranch.

The type section of the Wedin Member is under the west knob of hill 5300 in the south-central quadrant of the Altuda quadrangle, in the Lenox Hills (pl. 1). There the member consists of 20 feet of biohermal limestone containing abundant representatives of the brachiopod *Institella*. It pinches out about a mile east of the type section, but to the west it forms a prominent ledge on the north edge of the Lenox Hills. It is somewhat thinner on the northwest side of Dugout Mountain, where it has been mapped for about a mile by King and King (in P. B. King, 1931) as the "Fifth Limestone" member of the Leonard. Its total extent is about 6.5 miles, although much of its

strike lies in the covered valley between Dugout Mountain and the Lenox Hills.

The level of the Wedin Member is marked to the northeast nearly as far as Stockton Gap by the first appearance of *Institella* in the Cathedral Mountain Formation. The base of the formation is not defined by the appearance of this fossil, however; the formation is a distinctive lithic unit that was mapped as such by King and King (in P. B. King, 1931).

#### ROAD CANYON FORMATION

The Road Canyon Formation was the "First Limestone" member of the Word Formation, of P. B. King (1931). It was named by Cooper and Grant (1964) because it is one of the most distinctive and important units in the stratigraphy of the Glass Mountains. They left it as a member of the Word Formation but pointed out its biostratigraphic relationship to the underlying Cathedral Mountain Formation (Cooper and Grant, 1964, p. 1586). The Road Canyon is here raised to the rank of formation and transferred from the Guadalupe to the Leonard Series.

The brachiopods of the Road Canyon Formation clearly are more closely related to those of the Leonard Series than to those of the Word, a relationship suggested, but not fully explicit, in Cooper and Grant (1964, p. 1586-1587) and Cooper (in Dunbar and others, 1960, p. 1770, 1772). Full documentation of these relationships necessarily must await publication on the brachiopods. The ammonoid fauna, however, is well known (Miller and Furnish, 1940), and the presence of the genus *Perrinites* in the Road Canyon is offered as additional evidence for a Leonard age. W. M. Furnish and B. F. Glenister, University of Iowa, accompanied us to outcrops of the Road Canyon Formation in April 1965 and found abundant distinctive representatives of that genus, which in their opinion strongly suggest a Leonard age for the formation.

#### GUADALUPE SERIES

##### WORD FORMATION

Limestone members of the Word Formation (Udden, Baker, and Böse, 1916) were numbered 1-4 in ascending order by P. B. King (1931). Removal of the "First Limestone" member from the formation by establishing it as the Road Canyon Formation destroys the numbering system. The three limestone members of the Word are important because most of the Word fossils are known from them and not from the intervening shales; therefore, names are proposed here for the limestone members.

CHINA TANK MEMBER

The China Tank Member (new) is the "Second Limestone" member of the Word (P. B. King, 1931). It is here named for exposures near the cattle tank on the Hess Ranch known as the China Tank because of the nearby grove of chinaberry trees. The type section is P. B. King's (1931, p. 72) section 23 on the west side of hill 5611, just east of the fault that bounds the Hess Ranch horst in the west-central quadrant of the Hess Canyon quadrangle (pl. 1). The member is siliceous, brownish- to yellowish-gray limestone, and 113 feet thick; it contains abundant silicified fossils.

The China Tank Member is well displayed on the bluffs on the east side of Hess Canyon about 1.5 miles south of the head of the southwest branch of the canyon, due west of the Old Word Ranch (Hess Canyon quadrangle, pl. 1). It merges into the main mass of the Word Formation east of Old Word Ranch. The member has been mapped westward by King and King (in P. B. King, 1931) only in the vicinity of its type locality near the head of Hess Canyon; the member is not extensive.

WILLIS RANCH MEMBER

The type section of the Willis Ranch Member, herein named (the "Third Limestone" member of P. B. King, 1931), is near the eastern entrance to Road Canyon, 1 mile southwest of the Old Willis Ranch site in the west-central quadrant of the Hess Canyon quadrangle (pl. 1). This is locality 243 of R. E. King (1931, p. 136). P. B. King (1931, p. 71, section 18) measured 308 feet of limestone as follows:

"Third Limestone" member (Willis Ranch Member):	<i>Feet</i>
(d) Oolitic gray limestone in thin ledges.....	69
(c) Gray limestone, containing fossils, and several seams of small quartz pebbles.....	11
(b) Brown calcareous sandstone.....	10
(a) Light gray oolitic limestone, containing some chert masses and fossils, including <i>Waagenoceras</i> , <i>Prorichthofenia</i> ....	218

The Willis Ranch Member extends along the south side of Road Canyon, where it makes large patches on the dip slope (map in P. B. King, 1931). It curves northward and arcs under Gilliland Canyon, emerging on the west side of that canyon where it has been mistakenly mapped as the basal limestone member in the Word. The Willis Ranch Member was not assigned a number on the Kings' map, although it was identified as the "First Limestone" on plate 7 (P. B. King, 1931). However, the limestone on the west side of Gilliland Canyon now proves to be a continuation of the Willis Ranch Member, identified by its close lithic and faunal similarity to that member on the east side of the canyon where it is the "Third Limestone" member of King and

King (in P. B. King, 1931). The member terminates in the southwest corner of the mouth of the southward extension of Gilliland Canyon.

The Willis Ranch Member can be traced to the vicinity of the Old Word Ranch where it becomes dolomitic and merges with the undifferentiated mass of the Word Formation. Some of the richest deposits of silicified fossils are in the Willis Ranch Member.

#### APPLE RANCH MEMBER

The Apple Ranch Member, here named, was formerly designated the "Fourth Limestone" member of the Word (P. B. King, 1931). It is less extensive than the Willis Ranch Member but somewhat more extensive than the China Tank Member. Its type locality is north of the Apple Ranch house, which is about half a mile northeast of the site of the Old Word Ranch (pl. 1). P. B. King (1931, p. 143, section 24) measured the "Fourth Limestone" member there as follows:

"Fourth Limestone" member (Apple Ranch Member)	<i>Feet</i>
(c) Light gray crystalline limestone, very similar in appearance to the Edwards Limestone of the Comanche. It contains abundant small brown chert nodules as well as an abundant fauna of brachiopods, fusulinids, and other fossils....	260
(b) Gray and brown limestone and dolomitic limestone, containing some chert nodules and many silicified fossils, interbedded with sandy brown limestone and some siliceous shale.....	255
(a) Fossiliferous cherty dolomite, weathering to dirty gray deeply pitted surfaces.....	40

The Apple Ranch Member merges into the main body of the Word Formation about a mile east of the type locality, but it can be traced westward nearly to the site of the Old Willis Ranch (map in P. B. King, 1931). Silicified fossils are abundant at many places, and this member contains many species that do not occur in the lower members of the Word.

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